

Earth's Paleobiosphere

ES-6 The student will demonstrate an understanding of the dynamic relationship between Earth's conditions over geologic time and the diversity of its organisms.

ES-6.4 Match dating methods (including index fossils, ordering of rock layers, and radiometric dating) with the most appropriate application for estimating geologic time.

Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/future knowledge: Students in 8th grade were introduced to index fossils and to determining the relative age of rocks through the ordering of rock layers. Students have not studied radiometric dating before this indicator in Earth Science.

It is essential for students to know that rocks contain clues to Earth's past, including life forms and evidence of geologic change. Several ways to learn about and date Earth's past come from the type of rock found, the rock layers, and fossils found within some of the rocks. Methods of dating the Earth are determined by whether the need is for which came first and sequencing to later dates, or whether the need is for an actual age.

Relative Age Dating: (used if the need is for ordering oldest to youngest in geologic time)

Ordering Rock Layers

The geologic principles of *uniformitarianism*, *superposition*, and *cross-cutting relationships* help scientists to determine the ordering of rock layers and the changes that occur to those rock layers over time. Weathering and erosion can disturb the rock layering, and an intrusion or a fault can indicate younger or more recent changes to the rock layer(s) in which they are found.

Index Fossils: (used to aid in the ordering of rock layers or to age the rock layer)

Geologists use index fossils to correlate rock layers over large geographic areas and to date a particular rock layer.

- An *index fossil* must be easily recognized, have been abundant and widely distributed geographically. It also must have lived during a short period of time.
- With this information, a scientist can use index fossils to date the age of the rock layer based upon when that organism was known to have lived in geologic time.
- An index fossil found in rock layers in different areas of the world indicates that the rock layers were probably formed during the same period.

Radiometric/Absolute Age Dating: (used if the need is for knowing the actual age of a rock or fossil)

In order for scientists to determine the actual age, or *absolute age*, of a rock layer, radioactive isotopes of elements found in rocks or fossils are used.

- *Radioactive isotopes* give off energy and particles at a regular rate, not influenced by environment, temperature, or any other changes, and eventually change to other isotopes of that element or into an isotope of a different element. They function as a natural clock. This process is called *radioactive decay*.
- By knowing how long a radioactive element takes to decay into its “daughter” elements, and by determining the ratio of the original radioactive element still present compared to the amount of “daughter” element, the age of the rock being analyzed can be determined. Since this process takes a long period of time for most radioactive elements, geologists use the length of time it takes for one-half of the original amount to decay, called the *half-life*, to determine age. Students should know why uranium-238 may be used for one dating compared to carbon-14 in another instance.

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It is not essential for students to know the details of the particles given off or the various daughter elements that occur in the radioactive decay process; only a general understanding of radioactive decay is essential.

Assessment Guidelines:

The objective of this indicator is to *match* methods of dating rocks and fossils with appropriate need for the dating, therefore, the primary focus of assessment should be to determine from the need indicated whether relative dating, index fossils, or absolute/radiometric dating would be the best method to use.

In addition to match appropriate assessments may require students to:

- *summarize* the major points about each type of dating method;
- *compare* relative and absolute dating;
- *infer* the age of a rock through the use of half-life; or
- *recall* the geologic principles involved in relative dating.